

MICROPETASOS, A NEW GENUS OF ANGIOSPERMS FROM MID-CRETACEOUS BURMESE AMBER

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ABSTRACT

Micropetasos burmensis gen. & sp. nov. is described, based on an inflorescence of small flowers preserved in mid-Cretaceous amber from Myanmar (Burma). The flowers are ca. 1 mm in diameter, hypogynous, and have a perianth of 5 spreading, often unequal, basally connate sepals. Petals are absent. The numerous stamens have bisporangiate anthers and are of different lengths within the flower. As preserved, they are in a tight cluster appressed around the pistil. The gynoecium consists of a single carpel, whose short, curved style has an attenuate tip lacking an enlarged stigma. The pollen is triaperturate. The species has no clear affinity with a modern family, although its perianth and pollen characteristics place it within the eudicot clade Pentapetalae in phylogenetic systematics (Cantino et al. 2007).

RESUMEN

Se describe **Micropetasos burmensis** gen. & sp. nov. basado en una inflorescencia de flores pequeñas preservada en ámbar del Cretácico medio de Myanmar (Birmania). Las flores son de ca. 1 mm de diámetro, hipóginas, y tienen un perianto de 5 sépalos extendidos, a menudo desiguales, connados basalmente. Los pétalos están ausentes. Los numerosos estambres tienen anteras bisporangiadas y son de distinta longitud en la flor. Cuando están preservadas, se presentan en un grupo apesado alrededor del pistilo. El ginoecio consiste en un carpelo simple, cuyo estilo corto y curvado tiene una punta atenuada que carece de un estigma ensanchado. El polen es triaperturado. La especie no tiene una afinidad clara con ninguna familia moderna, aunque su perianto y polen característicos la colocan las eudicots en el clado de las Pentapétalas en la sistemática filogenética (Cantino et al. 2007).

INTRODUCTION

Burmese amber has been mined since AD 100, when an amber trade route was established with China. Around 1896, it was noted that the amber contained insect remains. In 2001, a new amber mine was opened in the Hukawng Valley, southwest of Maingkhwan in the state of Kachin (Poinar et al. 2005). Amber-bearing strata in this mine, known as the Noiye Bum 2001 Summit Site, were initially assigned to the Upper Albian (97–110 Ma) of the Early Cretaceous on the basis of paleontological (ammonite) and palynological evidence (Cruickshank & Ko 2003). More recently, Shi et al. (2012) give an age of 98.79 \pm 0.62 Ma, based on U-Pb analysis of zircons from the volcanoclastic matrix of the amber. This is slightly younger than the date of 100.5 Ma assigned to the end of the Albian by the International Commission on Stratigraphy (2013, <http://www.stratigraphy.org>). However, Shi et al. (op. cit.) contradict themselves in claiming that the amber has not been re-deposited, yet stating that the amber occurs in marine sedimentary rocks. If the amber is in marine sediments, then it must have been re-deposited, because amber is not formed in such an environment. Just when it was first formed in a terrestrial forest is not known, leaving the true age of amber from Myanmar in question. With re-deposition, the amber must be older than the zircon-based dates determined by Shi et al. (op. cit.).

The ancient age of amber from this site is supported by the presence of primitive insects in the deposit. For example, a bee was discovered that possessed some characters of sphecoid wasps, the taxon which, in traditional systematics, is considered to be ancestral to bees (Poinar & Danforth 2006). An elcanid grasshopper was also found, representing a group (Elcanoidea) that first appeared in the Early Permian and continued only to the mid-Cretaceous (Poinar et al. 2005). Thus, paleontological evidence, atomic dating, and the insect inclusions in the amber favor an early mid-Cretaceous age for mines at the Noiye Bum 2001 Summit Site. In their book on early flowers of the Cretaceous, Friis et al. (2011, p. 34) propose that Myanmar amber is Late Cretaceous or Early Cenozoic; however, they provide no new evidence in support of this revised date.

Nuclear magnetic resonance (NMR) spectra of samples taken from this locality indicate an araucarian (possibly *Agathis*) source of the amber (Poinar et al. 2007b). While insect fossils dominate (Grimaldi et al. 2002), the deposits have revealed some interesting plants, including 2 early bambusoid grasses (Poinar 2004), a staminate flower with affinities to the Monimiaceae (Poinar & Chambers 2005), an epigynous flower similar to Cornaceae (Poinar et al. 2007a), a pistillate, apetalous flower with possible connections to the rosid clade of eudicots (Poinar et al. 2008b), and an epigynous flower with characters paralleling some modern Cunoniaceae (Chambers et al. 2010, Grimaldi et al. 2002, fig. 13).

The present fossil consists of a basally bracteate fragment of a mixed cymose-paniculate inflorescence, 9 mm long (Fig. 1), whose branches bear 3–7 flowers on glabrous, relatively stout pedicels (Fig. 3). Eighteen flowers are present, but only 10 are positioned well enough for study. The perianth lacks petals, consisting of a single whorl of five basally connate sepals spreading laterally at anthesis (Fig. 2). The calyx lobes may be equal or unequal in size. The numerous stamens are tightly clumped around the pistil, perhaps becoming aggregated during preservation in the resin. On four flowers, 1 or 2 unusually long stamens are visible, separate from and external to the others (Figs. 2, 3), and some of these appear to have a broadened, ribbon-like filament (Fig. 2). The gynoecium consists of a single carpel bearing a short, curved, attenuate style, the ovary being mostly hidden by the surrounding mass of stamens (Fig. 3). Among eudicot flowers thus far described from this period (Friis et al. 2006, 2011), *Micropetasos* is distinctive in its combination of five connate, spreading sepals, no petals, numerous stamens with bisporangiate anthers, and a gynoecium comprising a single, superior carpel with an arcuate, attenuate style.

MATERIALS AND METHODS

The fossil inflorescence is preserved in a quadrilateral piece of amber with sides of 20, 15, 11, and 10 mm, which initially was part of a larger piece containing a fossil scorpion. It is in the amber collection of J. Wunderlich, Oberer Häuselbergweg 24, Hirschberg, Germany 69493, and will eventually be deposited in the Senckenberg Museum and Research Institute, Frankfurt-am-Main. The amber was obtained from the Noiye Bum 2001 Summit Site in the Hukawng Valley, Burma, as described above. Examination and photography were made with a Nikon stereoscopic microscope SMZ-10R at 80X and a Nikon Optiphot microscope at 800X.

DESCRIPTION

Micropetasos G.O. Poinar, K.L. Chambers & J. Wunderlich, gen. nov. TYPE SPECIES: *Micropetasos burmensis* G.O. Poinar, K.L. Chambers & J. Wunderlich.

Flowers small, in groups of 3–7 on branches of a basally bracteate, glabrous, mixed cymose-paniculate inflorescence (Fig. 1), pedicels relatively stout, glabrous, ebracteate (Fig. 3), flowers bisexual, hypogynous, calyx 5-merous, regularly or irregularly actinomorphic, sepals glabrous, basally connate, lobes triangular, obtuse or acute, equal or unequal (Fig. 2), petals none, stamens numerous, bunched around the pistil (Fig. 3), filaments linear, short on outer stamens, longer on those near the pistil, sometimes 1–2 outer filaments elongated (Figs. 2, 3), anthers small, oblong-ovoid, bisporangiate (Figs. 2, 3), connective not prolonged, gynoecium of 1 carpel, ovary conic or ovoid (hidden by the mass of appressed stamens), disc or nectaries, if any, not visible, style short, arcuate, attenuate, stigmatic area terminal, papillate, not enlarged.

Micropetasos burmensis G.O. Poinar, K.L. Chambers & J. Wunderlich, sp. nov. (Figs. 1–4). TYPE: MYANMAR (Burma). KACHIN: Noiye Bum 2001 Summit Site amber mine in the Hukawng Valley, SW of Maingkhwan, 26°20'N, 96°36'E, 2012, unknown amber miner s.n. (HOLOTYPE: accession no. F2469/BU/CJW, deposited in the amber collection of J. Wunderlich, Hirschberg, eventually to be deposited in the Senckenberg Museum and Research Institute, Frankfurt-am-Main, Germany).

Flowers 0.8 mm in diameter at anthesis, connate portion of calyx 0.13 mm, lobes 0.26–0.30 mm, stamens 60+, filament length variable, anthers 0.06–0.10 mm, ovary 0.51 mm long, 0.38 mm wide, style 0.18 mm, pedicels 0.26–0.64 mm, pollen triaperturate (Fig. 4), diameter 10–14 μ m.

Etymology.—Genus name from the Greek “micro,” small, and “petasos,” broad-brimmed hat, from the imagined shape of the flowers at anthesis. Species name from the country of origin of the fossil.

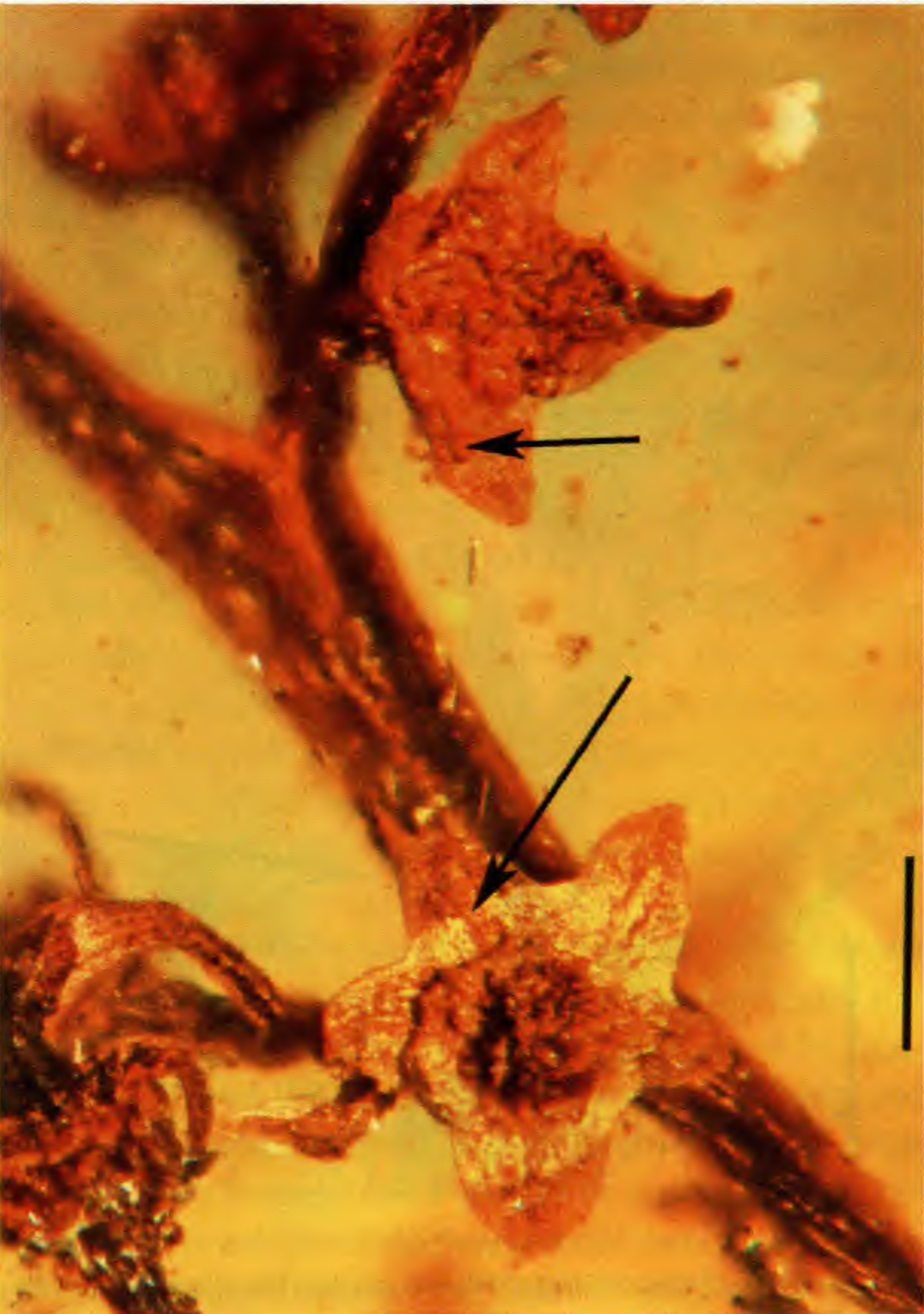
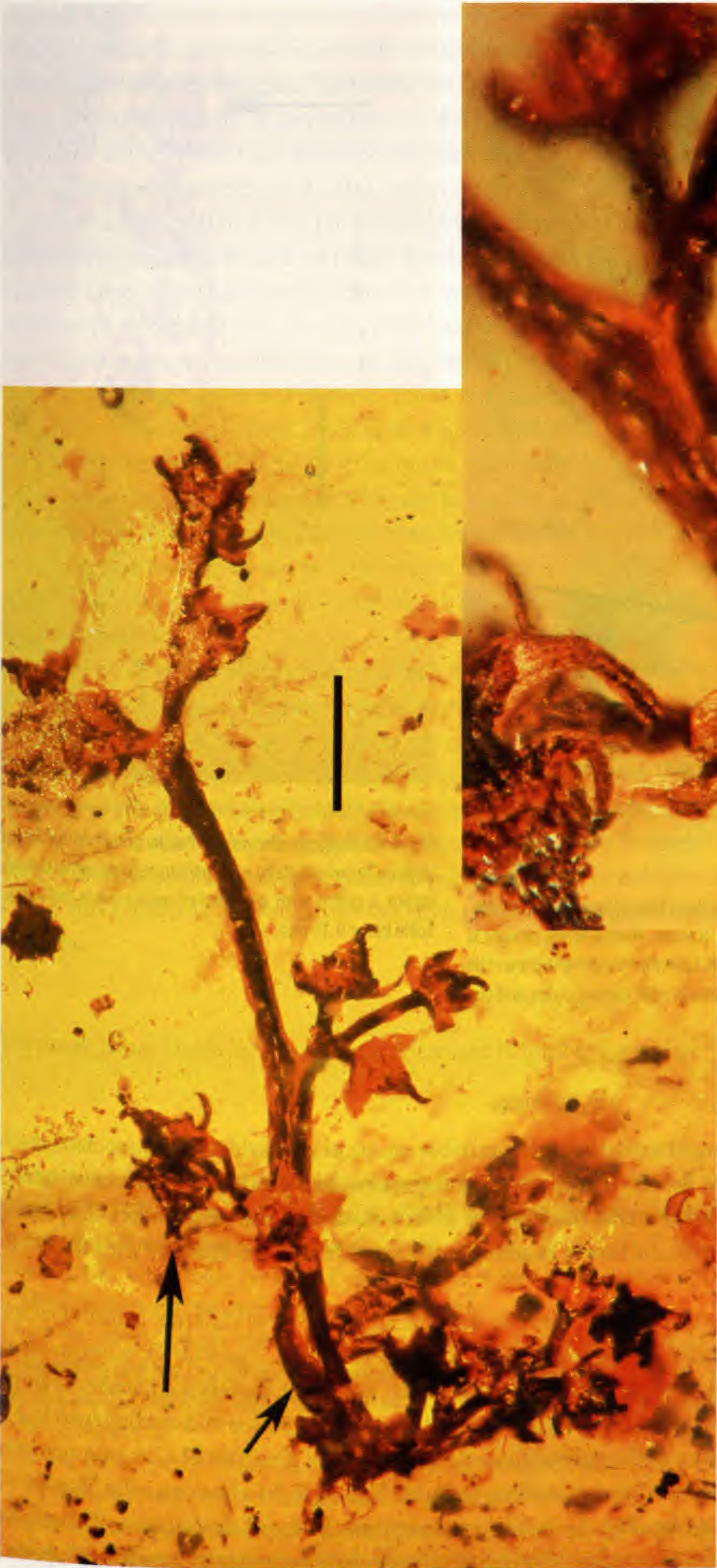


FIG. 2. *Micropetasos burmensis*. Two flowers in lateral and apical view. Upper arrow shows an anther of a long stamen lying against a calyx lobe. Lower arrow is on a ribbon-like filament of a long outer stamen. Note varying sizes of calyx lobes. Scale bar = 0.31 mm.

FIG. 1. *Micropetasos burmensis*. Entire inflorescence. Left arrow points to an aberrant carpel with 2 styles. Right arrow is on a single bract at the base of the inflorescence.. Scale bar = 1.2 mm.

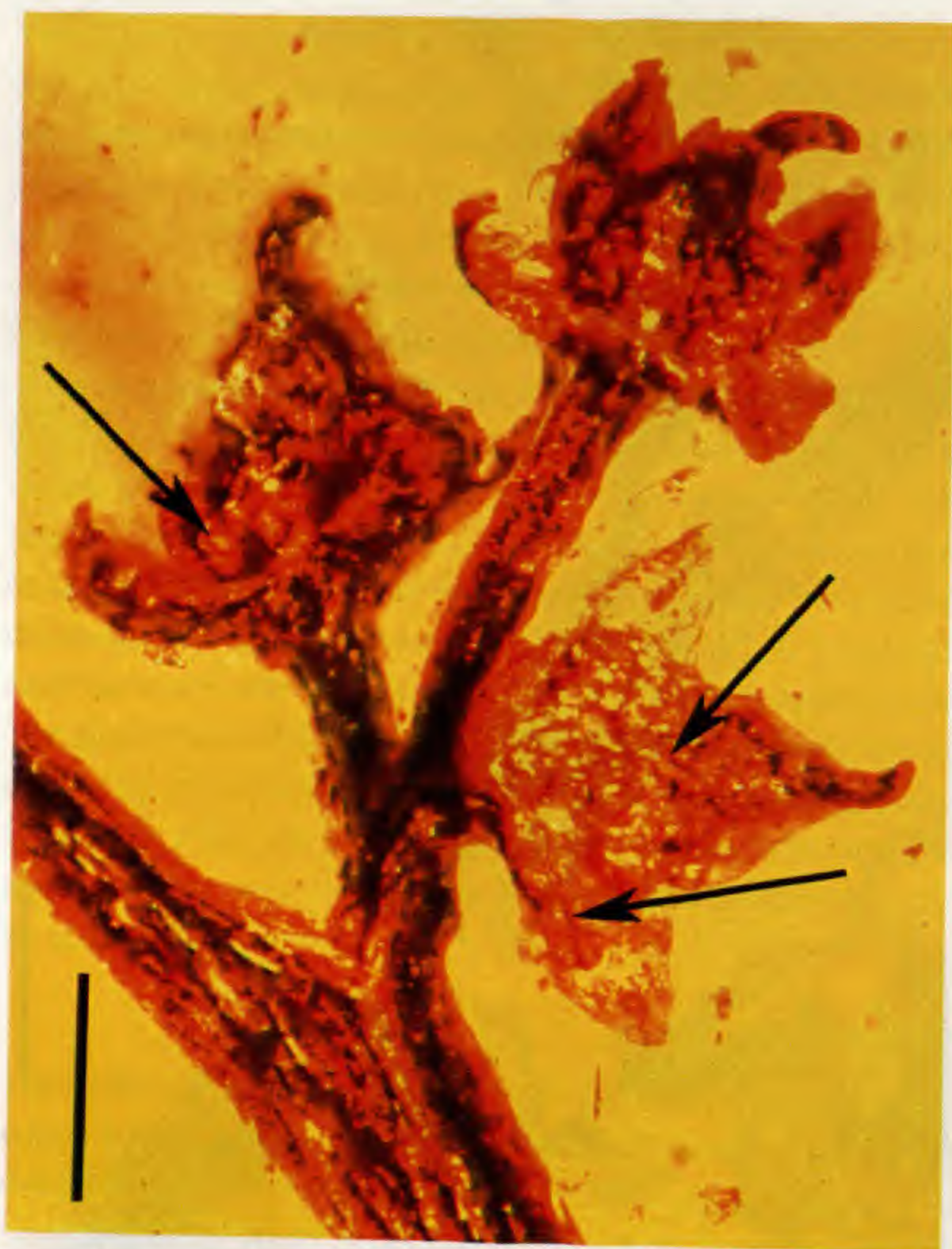


FIG. 3. *Micropetasos burmensis*. Group of 3 flowers on a short lateral branch of the inflorescence. Left arrow points to anther of a short outer stamen. Middle arrow at right is on a mass of long inner stamens appressed to the pistil. Lower arrow at right shows the linear filament of an elongated outer stamen. Note pistils with curved styles and the stout floral pedicels. Scale bar = 0.38 mm.



FIG. 4. *Micropetasos burmensis*. Pollen grains on surface of stigma. Arrow points to a triaperturate grain with contents intact. 4 grains with germinated pollen tubes are below. Scale bar = 0.16 mm.

DISCUSSION

In some modern families with a single superior carpel, such as Fabaceae, a curved style may be associated with an overall zygomorphic symmetry of the flowers. However, in *Micropetasos* the style does not arch consistently toward the largest or the smallest calyx lobe, and the stamens evenly surround the pistil rather than being displaced to one side. We therefore describe the flower as actinomorphic, although it is bilateral with respect to the pistil.

Interpretation of the androecium is difficult because the stamens appear to be of different lengths and the longer, inner ones have adhered to the pistil, perhaps as an artifact of preservation. The shorter, outer stamens on several flowers, although closely packed, are free from each other, and their undehiscent anthers can be distinguished (Fig. 3). Anthers of the longer stamens have mostly given up their pollen and are flattened into a formless mass (Fig. 3). An irregular feature of the androecium is the occasional presence of a long stamen outside the main group, either lying against the calyx or standing upright (Figs. 2, 3). In a few cases the filament of these stamens is broadened and ribbon-like (Fig. 2). It is interesting that the fossil described as *Paleoclusia* (Crepet & Nixon 1998) also had stamens of unequal lengths, grading from short outer to long inner (op. cit., Fig. 6). The stamens of this species were fascicled, however, and the gynoecium was 5-carpelled with sessile, peltate stigmas, petals were present, and the sepals appear to have been free.

An irregularity in the gynoecium is present in one flower of *Micropetasos*, where two styles are present, one short, straight, and appressed to the usual longer, curved one (Fig. 1). It is unclear whether this indicates a fully bicarpellate gynoecium. Our ability to detect these kinds of developmental variations is due to the rare example of a fossil in which several flowers of the species are connected in an inflorescence, as contrasted to the usual case where flowers are detached and only one or two can be assigned to the same taxon (but see Poinar et al. 2008a and Chambers et al. 2012, where six and four flowers, respectively, were available). In an example cited by Friis et al. (2011, p. 32), two coalified fossil flowers of *Lasistemon*, male and female, could be associated through the presence, in both, of pollen having a distinctive exine pattern. From the example of *Micropetasos*, one might speculate that floral development was more flexible, i.e. less canalized, in the early evolution in some angiosperm clades, but that this has gone undetected because the descriptions of fossil taxa have commonly been based on one or a few flowers. In deposits of coalified or lignified flowers, where large numbers of specimens are collected together (Friis et al. 2011), it is possible that this drawback can be overcome.

The consistent curvature of the style, together with the relatively stout floral pedicels of *Micropetasos*, may have been associated with insect pollination, especially given the small size of the flowers. The presence of pollen grains on the style and calyx but not in the surrounding amber suggests that the grains may have been adhesive. This feature would facilitate attachment to the body of visiting insects. Small insects would be the most likely pollinators of minute flowers such as those of *Micropetasos burmensis*. *Melittosphex burmensis*, a tiny bee just less than 3 mm in length that lived in the Burmese amber forest (Danforth & Poinar 2011), is a possible candidate.

A possible relationship of *Micropetasos* with a modern family in one of the redefined clades of eudicots (APGIII, Stevens 2001 onward) is problematic. Features such as hypogyny, a connate calyx, numerous stamens, a single carpel, and a curved style are suggestive of certain members of the Fabaceae. However the similarity is only superficial, because the inflorescence differs from the racemose type found in that family, and numerous stamens occur principally in the highly derived subfamily Mimosoideae. Furthermore, molecular phylogenetic studies date the origin of Fabaceae to the Early Tertiary (Lavin et al. 2005). In terms of phylogenetic systematics, *Micropetasos* appears to represent an early member of the Pentapetalae clade (Cantino et al. 2007), also known as core eudicots. We prefer to leave the question of its exact familial relationships open at this time.

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